

tion and use of the microscope; especial attention being given to forms of the instrument, like those devised by Nachet and by the author of this work, for the special purpose of studying crystallization and other physical and chemical processes.

The second division of the book treats of those physical properties of matter which are presented by all bodies, whether in the solid, liquid, or gaseous state. Such questions as the polarization and absorption of light, the conduction of heat, and the electric and magnetic relations of various substances are here dealt with by the author.

The next division relates to the peculiar properties presented by solids. Elasticity and plasticity are considered, and, under the latter head, the remarkable phenomenon of the production of twinned structures in crystals by mechanical means is fully discussed. Under the head of cleavage we find a treatment of such phenomena as the production of mathematical figures in certain crystals by pressure, percussion, &c.; while under the heads of "Enantiotropie" and "Monotropie" are classified the consequences which follow from heteromorphism among crystalline substances, and the tendency of the heteromorphous forms to pass one into the other.

The division dealing with liquids and their peculiar properties contains discussions on fluidity, surface-tension, diffusion, capillarity, and crystal-growth, with the origin of structural anomalies. The problems of solution and precipitation, with those of solidification and fusion, are also treated of in this part of the treatise.

The second volume of the work commences with the discussion of the properties of gases and their relations to solids and liquids. This division of the subject, which is very exhaustively treated, extends to 335 pages.

The work concludes with critical remarks upon different molecular theories. The chapters dealing with the theories of crystal structure, of allotropy, of heteromorphism, and of isomerism, with several others, in the same division of the book, are full of interest and suggestiveness.

A supplement of about 150 pages is devoted to what the author calls "crystal-analysis," or what is generally known to geologists and mineralogists as "microchemical analysis." Very minute particles of an unknown substance may often be determined by being treated with appropriate reagents and studied under the microscope; in this way they are made to yield crystals of various compounds which can be recognized by their characteristic forms and habit. An admirable summary is given by the author of the work of Bôricky, Streng, Behrens, Haushofer, and others, who have gradually perfected this branch of research, and made the method one which is of the very greatest service to the students of microscopical mineralogy and petrography.

While the physicist and chemist will find in this work a perfect mine of interesting and ingenious experiments (many of which are suited to class-demonstrations by projection methods), the mineralogist and geologist will hail the appearance of the book as one that completes and supplements the well-known treatise of Vogelsang—a work that has exercised the most important influence on the development of petrological theory.

In conclusion, it may be pointed out that, not only are

the numerous observations of the author on crystallogeneses that are described in memoirs in *Groth's Zeitschrift* included in the work before us, but many others that have never before been published find a place in these volumes. The work is very fully illustrated both with woodcuts and coloured plates, and constitutes a complete synopsis of all that is known on a number of questions of great importance and interest to workers in many different branches of science.

BERTRAND ON ELECTRICITY.

Leçons sur la Théorie Mathématique de L'Électricité, professées au Collège de France. Par J. Bertrand. (Paris: Gauthier-Villars.)

THIS book contains lectures on electricity given by M. Bertrand at the Collège de France. In his preface the author states that he has confined himself to the mathematical principles of the subject; but this hardly expresses the limitation he has imposed upon himself, for a great many results which English students of electricity are accustomed to find in text-books on this subject are omitted from this work. A brief description of the contents of the book will suffice to show this. The first chapter contains an investigation of the attractions of spheres and spherical surfaces when the law of attraction is inversely as the square of the distance; the second and third are devoted to the properties of the potential; the fourth contains an investigation of the conditions under which the method of lines of force can be used; the fifth, which has the comprehensive title "Électricité Statique," contains a short discussion of the electrical distribution on two spheres which mutually influence each other, the reciprocal theorems, and a discussion of the properties of the Leyden jar so far as they can be discussed without introducing the idea of specific inductive capacity; the sixth chapter contains some remarks upon magnets; the seventh treats of Ohm's law, and contains Kirchhoff's equations for the distribution of currents amongst a network of conductors, without, however, any applications even to such an important case as that of Wheatstone's bridge; the eighth, ninth, and tenth chapters contain, respectively, investigations of the magnetic forces produced by linear currents, the laws according to which such currents act on each other, and simple applications of these laws; the eleventh chapter contains some account of the induction of currents, and, amongst other things, some well-founded reasons for not deducing the laws of induction from the principle of the conservation of energy alone, but no hint is given of the possibility of regarding a system of currents as a dynamical system, though the introduction of this idea by Maxwell has thrown new light over the whole subject and enabled many of the properties of currents to be recognized at once as those belonging to any dynamical systems; the twelfth chapter contains some account of the application of the results of the previous chapters to dynamo-electric machines; and the thirteenth and last chapter discusses units.

There are two views which have been taken as to the relation between the mathematics and the physics, which ought to exist in a text-book on mathematical physics: the one is, that it is the province of physics to supply the

laws of action between particles charged with electricity, elements of current, and the like; then its function ceases, and the rest is a mere matter of mathematical symbols; by this method the physics and the mathematics are sharply divided—the physics occurs in the first few lines of the chapter, the rest of which is mathematics. In the other method the physics and mathematics are kept as closely connected as possible, so that by knowing from physics the kind of results we may expect errors in the mathematical investigations may be detected; while, on the other hand, our physical conceptions may be extended, and perhaps even the point of view changed, by the results of mathematical transformations. Thus, as Maxwell points out, the two sides of the equation which expresses Green's theorem might have suggested the two ways of regarding electrical phenomena—the one when we confine our attention to the electrified bodies; the other when we look upon the dielectric as the seat of the phenomena. In the department of physics in which mathematical analysis has won perhaps its greatest triumphs, that of gravitational attraction, the first method is perhaps the most natural; but in an intricate subject like electricity, where so much remains to be discovered, and which it is so important to regard from as many points of view as possible, the second method seems infinitely the more likely to lead to an extension of our knowledge.

M. Bertrand's work is a most favourable example of the first method: it is clearly and gracefully written, and the mathematical part often extremely elegant; yet, in spite of all this, we must confess to a feeling of disappointment on reading the book. We had thought from the publication of Mascart and Joubert's "Leçons sur l'Électricité et le Magnétisme," and the excellent translation of Maxwell's "Electricity and Magnetism" by MM. Seligman-Lui, and Cornu, that the ideas introduced by Maxwell, von Helmholtz, and others, were spreading in France; yet here we have a work written by one of the first scientific men of that country, in which the subject is treated in fundamentally precisely the same way as that in vogue twenty or thirty years ago; and in fact, with the exception of some results due to M. Marcel Deprez, in the chapter on electro-magnetic machines, there is no reference to any investigation made within the last twenty years. The names of Maxwell and von Helmholtz are not even mentioned in the book itself—though, to be quite accurate, that of Maxwell occurs in the table of contents in connection with a particular case of Green's theorem.

M. Bertrand seems to exact more from the science of electricity, before he deems it worthy to be discussed mathematically, than is exacted from any other science; thus, for example, he omits all consideration of the effect of the dielectric because there is no satisfactory molecular theory of specific inductive capacity, such as Mossotti attempted by supposing the dielectric to contain conducting spheres, the specific inductive capacity depending on the ratio of the volume of the spheres to that of the rest of the dielectric. It seems to us that if M. Bertrand were to write a book about optics, he would, if he were consistent, leave out everything connected with either refraction or reflection, since no complete molecular theory of these phenomena have been given. The way in which the dielectric affects the lines of force is as definite and simple as the way in which a refracting medium affects

the rays of light, and the one is quite as capable of receiving mathematical treatment as the other.

Again, M. Bertrand, in treating of magnetism, points out that on the theory of magnetic fluids the behaviour of a magnetized body will depend upon the shape of the molecules, and as this is not known he refuses to investigate the magnetic properties of bodies; he never mentions magnetic permeability, the idea of which, by introducing a new property of bodies, enables us to investigate mathematically their magnetic properties, and express the results of the investigation in terms of quantities which can be measured in a physical laboratory.

In spite of the clearness and elegance of this book, we are afraid that a student who learnt his electricity from it would think, if he read any modern memoirs on the subject, that they dealt with some new and unknown science; for the mode of regarding the phenomena would probably be entirely different, and many quantities would be introduced of whose existence M. Bertrand had given him no hint.

OUR BOOK SHELF.

Sundevall's Tentamen [*Methodi naturalis avium disponendarum tentamen*]. Translated into English, with Notes, by Francis Nicholson, F.Z.S., &c. (London: R. H. Porter, 1889.)

THE practice of translating into English memoirs by leading foreign naturalists that may be considered classical is to be highly commended. English ornithologists who are not conversant with German may thus study such important works in their branch of science as Nitzsch's "Pterylographie" and Johannes Müller's "Voice Organs of Passeres," of both of which excellent English translations exist.

It is, however, a question whether Sundevall's "Tentamen" comes into the category of classical memoirs, or is worth translating if it does. In our opinion it might have been allowed to drop peacefully into oblivion in the obscurity of the original Latin. No particular object is gained by helping to perpetuate a scheme of bird-classification like that of Sundevall, with the details of which no one nowadays can agree. Even the translator has nothing to say for it, except the very general statement that "every serious scheme of classification contains some items of progressive knowledge towards the attainment of a complete natural arrangement of the class of birds." It would be very difficult, however, to say what these items are, and the translator gives us no help in the matter. On the other hand, if ornithologists believe that this, the last work of Sundevall, is really important, then it can be certainly said that Mr. Nicholson's translation is good and accurate.

The introduction, which occupies the first twenty-five pages, is interesting, and so are the notes interspersed through the volume; but it is clear that the book must be entirely judged by the merits or demerits of the scheme of classification. Prof. Newton (article "Ornithology," in "Encyc. Brit.," ninth edition) has subjected Sundevall to a searching criticism, which seems to us to be perfectly justified. Some of the worst features of the classification—in addition to those mentioned by Prof. Newton—are to associate *Serpentarius* with any other birds of prey, to place the American vultures near the American kites (an error which is constantly cropping up in spite of the obvious anatomical differences), *Glareola* among the goatsuckers, &c. Prof. Sundevall's classification is, in fact, most reactionary in every particular; it is difficult to believe that it was published in the year 1872—after the appearance of so many important papers upon bird classification and structure, such as those of Profs. Huxley and Parker.